

What is Claimed is:

1. A foam composition comprising:
  - at least one fluoride compound that is free of both organoammonium and amine carboxylate compounds;
  - 5 at least one solvent;
  - at least one gas;
  - at least one surfactant; and
  - water.
- 10 2. The foam composition of Claim 1 wherein said at least one gas is selected from the group consisting of nitrogen, argon, helium, air, oxygen, carbon dioxide, and ozone.
3. The foam composition of Claim 1 wherein said at least one surfactant is selected from the group consisting of anionic surfactants, cationic surfactants, nonionic surfactants,  
15 amphoteric surfactants, and silicone based surfactants.
4. The foam composition of Claim 1 wherein the fluoride compounds are selected from the group consisting of ammonium fluoride, ammonium bifluoride or hydrogen fluoride.
- 20 5. The foam composition of Claim 1 additionally comprising a corrosion inhibitor selected from the group consisting of catechol, t-butyl catechol, pyrogallol, gallic acid and benzotriazole.
6. The foam composition of Claim 1 additionally comprising a chelating agent.
- 25 7. The foam composition of Claim 1 wherein the fluoride compound concentration ranges from about 0.01 percent to about 5 percent by weight.
8. The foam composition of Claim 1 wherein said at least one solvent is an organic amide  
30 solvent.
9. The foam composition of Claim 8 wherein the organic amide solvent concentration ranges from about 20 percent to about 80 percent by weight.
- 35 10. The foam composition of Claim 8 additionally comprising up to about 50 weight percent of an organic sulfoxide solvent.

11. The foam composition of Claim 10 wherein said organic sulfoxide solvent is dimethyl sulfoxide.

12. The foam composition of Claim 1 additionally comprising an alkylamide.

5 13. The foam composition of Claim 1 additionally comprising an alkanolamine.

14. The foam composition of Claim 13 wherein the alkanolamine is monoethanolamine.

15. The foam composition of Claim 1 wherein the organic solvent is a lactam.

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16. The foam composition of Claim 15 wherein the lactam is selected from the group consisting of: a 5-member ring lactam substituted with an alkyl group, a 6-member ring lactam substituted with an alkyl group, a 7-member ring lactam substituted with an alkyl group, a piperidone substituted with an alkyl group, and a piperidone substituted with an alkoxy group.

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17. The foam composition of Claim 16 wherein any of said alkyl groups comprises from 1 to 5 carbon atoms.

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18. The foam composition of Claim 16 wherein said alkoxy group comprises from 1 to 5 carbon atoms.

19. The foam composition of Claim 16 wherein the lactam is additionally a piperidone selected from the group consisting of dialkyl, and dialkoxy-substituted piperidones.

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20. The foam composition of Claim 16 wherein the piperidone substituted with an alkyl group is selected from the group consisting of N-methyl piperidone, dimethyl piperidone, N-ethyl piperidone and diethylpiperidone.

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21. The foam composition of Claim 16 wherein the piperidone substituted with an alkoxy group is selected from the group consisting of: N-methoxy piperidone, dimethoxy piperidone and diethoxy piperidone.

22. The foam composition of Claim 1 wherein the water is deionized water.

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23. The foam composition of Claim 1 suitable for treating a substrate having a surface to

which undesired matter adheres.

24. A foam composition comprising:

at least one hydroxylamine;

at least one alkanolamine;

5 at least one gas;

at least one surfactant; and,

at least one solvent.

25. The foam composition of Claim 24 wherein said at least one gas is selected from the  
10 group consisting of nitrogen, argon, helium, air, oxygen, carbon dioxide, and ozone.

26. The foam composition of Claim 24 wherein said at least one surfactant is selected from  
the group consisting of anionic surfactants, cationic surfactants, nonionic surfactants,  
amphoteric surfactants, and silicone based surfactants.

15 27. The foam composition of Claim 24 wherein the hydroxylamine concentration ranges  
from about 5 to about 50 percent by weight.

28. The foam composition of Claim 24 wherein the at least one alkanolamine concentration  
20 ranges from about 10 to about 80 percent by weight.

29. The foam composition of Claim 24 wherein the alkanol group of the alkanolamine  
contains from 1 to 5 carbon atoms.

25 30. The foam composition of Claim 24 wherein the alkanolamine is selected from the  
group consisting of monoalkanolamines, dialkanolamines, and trialkanolamines.

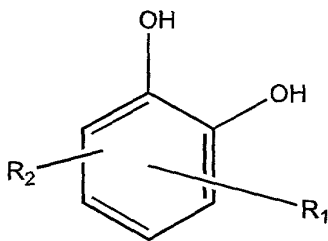
31. The foam composition of Claim 24 wherein the alkanolamine has a formula  
 $R_1R_2-N-CH_2CH_2-O-CH_2CH_2OH$  wherein  $R_1$  and  $R_2$  independently selected from the group  
30 consisting of H,  $CH_3$ ,  $CH_3CH_2$ , and  $CH_2CH_2OH$ .

32. The foam composition of Claim 24 additionally comprising a chelating agent.

33. The foam composition of Claim 32 wherein the chelating agent concentration ranges  
35 from about 2.5 to about 30 percent by weight.

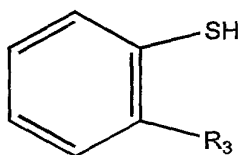
34. The foam composition of Claim 32 wherein the chelating agent is selected from the group consisting of:

(1) compounds of formula:



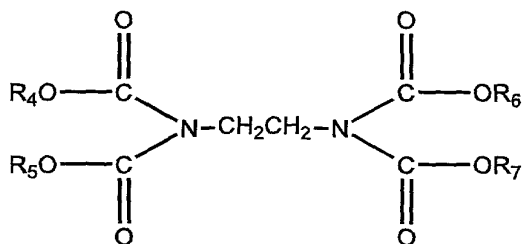
wherein R<sub>1</sub> and R<sub>2</sub> can be either H, t-butyl, OH, or COOH;

(2) compounds of formula:



wherein R<sub>3</sub> is either OH or COOH; and

(3) ethylene diamine tetracarboxylic acid compounds of formula:



wherein R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub> and R<sub>7</sub> can independently be either H or NH<sub>4</sub><sup>+</sup>.

35. The foam composition of Claim 24 wherein the solvent is deionized water.

36. The foam composition of Claim 24 wherein the alkanolamine is miscible with the hydroxylamine.

37. The foam composition of Claim 24 additionally comprising an acid.

38. The foam composition of Claim 37 wherein the acid is present in less than about 10 % by weight.

39. The foam composition of claim 24 wherein the at least one solvent includes an organic polar solvent.

40. The foam composition of claim 39 wherein the organic polar solvent is a glycol, a glycol alkyl ether, an alkyl N-substituted pyrrolidone, ethylene diamine or ethylene triamine.

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41. The foam composition of Claim 24 suitable for treating a substrate having a surface to which undesired matter adheres.

42. A foam composition comprising:

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- at least one amine;
- at least one solvent;
- at least one gas; and
- at least one surfactant.

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43. The foam composition of Claim 42 wherein the at least one amine is selected from the group consisting of morpholine, 2-methylamine ethanol, choline, and a choline derivative.

44. The foam composition of Claim 43 wherein the morpholine concentration ranges from about 40 to about 60 percent by weight.

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45. The foam composition of Claim 43 wherein the 2-methylamine ethanol concentration ranges from about 1 to about 10 percent by weight.

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46. The foam composition of Claim 43 wherein the choline derivative is choline hydroxide and its concentration ranges from about 10 to about 50 percent by weight.

47. The foam composition of Claim 46 additionally comprising hydroxylamine in a concentration that ranges from about 1 to about 10 percent by weight.

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48. The foam composition of Claim 42 wherein the at least one amine is selected from the group consisting of monoethanolamine, diglycol amine, di(ethylene triamine), tri(ethylene tetramine, 2-methylamine ethanol, choline hydroxide, bis(2-hydroxyethyl) dimethyl-ammonium hydroxide, tris(2-hydroxyethyl)dimethylammonium hydroxide, and choline bicarbonate.

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49. The foam composition of Claim 42 wherein the hydroxylamine comprises at least one

compound selected from the group consisting of: hydroxylamine salts, hydrazine, hydrazine salts, and an organic derivative of hydroxylamine with the formula  $R_1R_2N-OH$ , wherein at least one of  $R_1$  or  $R_2$  is an alkyl group containing 5 or fewer carbons.

50. The foam composition of Claim 42 wherein the organic derivative of hydroxylamine is di(ethyl) hydroxylamine or isopropyl hydroxylamine.

51. The foam composition of Claim 42 wherein the solvent comprises at least one solvent selected from the group consisting of N-(2-hydroxyethyl)-2-pyrrolidone, di(methyl) formamide, di(methyl) acetamide, ethylene carbonate, propylene carbonate, di(propylene glycol) monomethyl ether, ethyl lactate, propyl lactate, butyl lactate, propylene glycol and deionized water.

52. The foam composition of Claim 42 wherein the gas is selected from the group consisting of nitrogen, argon, helium, air, oxygen, carbon dioxide, and ozone.

53. The foam composition of Claim 42 wherein the surfactant is selected from the group consisting of: anionic surfactants, cationic surfactants, nonionic surfactants, amphoteric surfactants, and silicone based surfactants.

54. The foam composition of Claim 42 additionally comprising at least one corrosion inhibitor.

55. The foam composition of Claim 54 wherein the corrosion inhibitor is selected from the group consisting of catechol, t-butyl catechol, pyrogallol, gallic acid and benzotriazole.

56. The foam composition of Claim 43 wherein the solvent is selected from the group consisting of N-methyl pyrrolidone,  $\gamma$ -butyrolactone, dimethyl sulfoxide and propylene glycol.

57. The foam composition of Claim 56 wherein the N-methyl pyrrolidone concentration ranges from about 20 to about 50 percent by weight.

58. The foam composition of Claim 56 wherein the  $\gamma$ -butyrolactone concentration ranges from about 5 to about 25 percent by weight.

59. The foam composition of Claim 56 wherein the dimethyl sulfoxide concentration

ranges from about 20 to about 50 percent by weight.

60. The foam composition of Claim 56 wherein the propylene glycol concentration ranges from about 20 to about 80 percent by weight.

5 61. The foam composition of Claim 42 suitable for treating a substrate having a surface to which undesired matter adheres.

62. A foam composition comprising:

periodic acid;  
10 at least one gas;  
at least one surfactant; and,  
deionized water.

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63. The foam composition of Claim 62 additionally comprising at least one base selected  
15 from the group consisting of potassium hydroxide, sodium hydroxide, ammonium  
hydroxide, tetramethylammonium hydroxide, trimethyl(2-hydroxyethyl)ammonium  
hydroxide (choline), and choline derivatives.

64. The foam composition of Claim 62 additionally comprising a corrosion inhibitor  
20 selected from the group consisting of catechol, t-butyl catechol, pyrogallol, gallic acid and  
benzotriazole.

65. The foam composition of Claim 62 wherein the gas is selected from the group  
consisting of nitrogen, argon, helium, air, oxygen, carbon dioxide, and ozone.

25 66. The foam composition of Claim 62 wherein the surfactant is selected from the group  
consisting of anionic surfactants, cationic surfactants, nonionic surfactants, amphoteric  
surfactants, and silicone based surfactants.

30 67. The foam composition of Claim 62 suitable for treating a substrate having a surface to  
which undesired matter adheres.

68. A foam composition for treating a surface of a substrate comprising:

at least one amine;  
35 at least one acid selected from the group consisting of citric acid, formic acid, acetic  
acid, propionic acid, n-butyric acid, iso-butyric acid, benzoic acid, ascorbic acid, gluconic

acid, malic acid, malonic acid, oxalic acid, succinic acid, tartaric acid, and gallic acid;  
at least one gas selected from the group consisting of nitrogen, argon, helium, air,  
oxygen, carbon dioxide, and ozone;  
at least one surfactant selected from the group consisting of anionic surfactants,  
cationic surfactants, nonionic surfactants, amphoteric surfactants, and silicone based  
5 surfactants, wherein at least one surfactant is suitable to allow foaming;  
at least one chelating agent selected from the group consisting of  
ethylenediaminetetraacetic acid, citric acid, oximes, lactic acid, 8-hydroxy quinoline,  
salicylic acid, and salicylaldehyde;  
at least one corrosion inhibitor selected from the group consisting of catechol, t-  
10 butyl catechol, pyrogallol, gallic acid and benzotriazole; and  
deionized water.

69. The foam composition of Claim 68 wherein the amine is selected from the group  
consisting of hydroxylamine, hydroxylamine salts, hydrazine, hydrazine salts, quaternary  
15 amines, and ammonium hydroxide.
70. The foam composition of Claim 68 wherein the concentration of amines is sufficient to  
buffer the composition to a pH of 4 to 6.
- 20 71. The foam composition of Claim 68 wherein the concentration of acid ranges from about  
2.0 to about 11 percent by weight.
72. The foam composition of Claim 68 wherein the concentration of chelating agents is less  
than or equal to about 1.0 percent by weight.
- 25 73. The foam composition of Claim 69 wherein the concentration of surfactants ranges  
from about 0.05 to about 3.0 percent by weight.
74. The foam composition of Claim 68 suitable for treating a substrate to which undesired  
30 matter adheres.
75. A foam composition comprising: a gas; a surfactant; deionized water; and a component  
selected from the group consisting of a fluoride other than HF, a hydroxylamine, an amine  
and periodic acid.
- 35 76. A foam composition of claim 75 additionally comprising a corrosion inhibitor.



77. A foam composition of claim 76 additionally comprising a chelating agent.

78. A foam composition of claim 76 additionally comprising a non-aqueous solvent.

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